Error Analysis of Ecological Site Maps in the Southern Arizona

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Introduction

Ecological sites are defined as "a distinctive kind of land with specific physical characteristics and ability to produce a distinctive kind and amount of vegetation" (NRCS, 2003). Ecological sites concepts were developed by the USDA-NRCS as the unit of analysis for rangeland management.

Criteria for ecological sites are
- Representative species groups
- Definite proportion of species groups
- Characteristic soil properties affecting ecological processes
- Variation in kind, proportion, and production of the over-story and understory plants in response to soil, topography, climate, environment factors, and management.

Ecological sites define potential transitions in an area; thus capturing spatial and temporal heterogeneity. Ecological site mapping for an area includes detailed soil survey and vegetation study. However, collecting fine-scaled field data required for ecological site maps is time consuming, expensive and tedious. So, we are looking for alternatives to reduce the field work, yet get a preliminary understanding about ecological sites in an area. Preliminary ecological site maps created from the Soil Survey Geographic (SSURGO) database could be an option to create first-cut ecological site maps, especially for areas which do not have a field based ecological site map.

The main goal of this study was to assess the accuracy of first-cut ecological site maps created from the SSURGO database with respect to the field based ecological site maps. If accurate, SSURGO can be used to generate preliminary ecological site maps for areas where field based ecological site maps have not been developed.

Objectives

1) To analyze the quality of the ecological site map generated from the Soil Survey Geographic (SSURGO) soil database

2) To examine the map errors and explore potential ways to reduce them

Study Area

Walnut Gulch Experimental Watershed (WGEW) is the most densely instrumented and well-researched semi-arid watershed in the world.
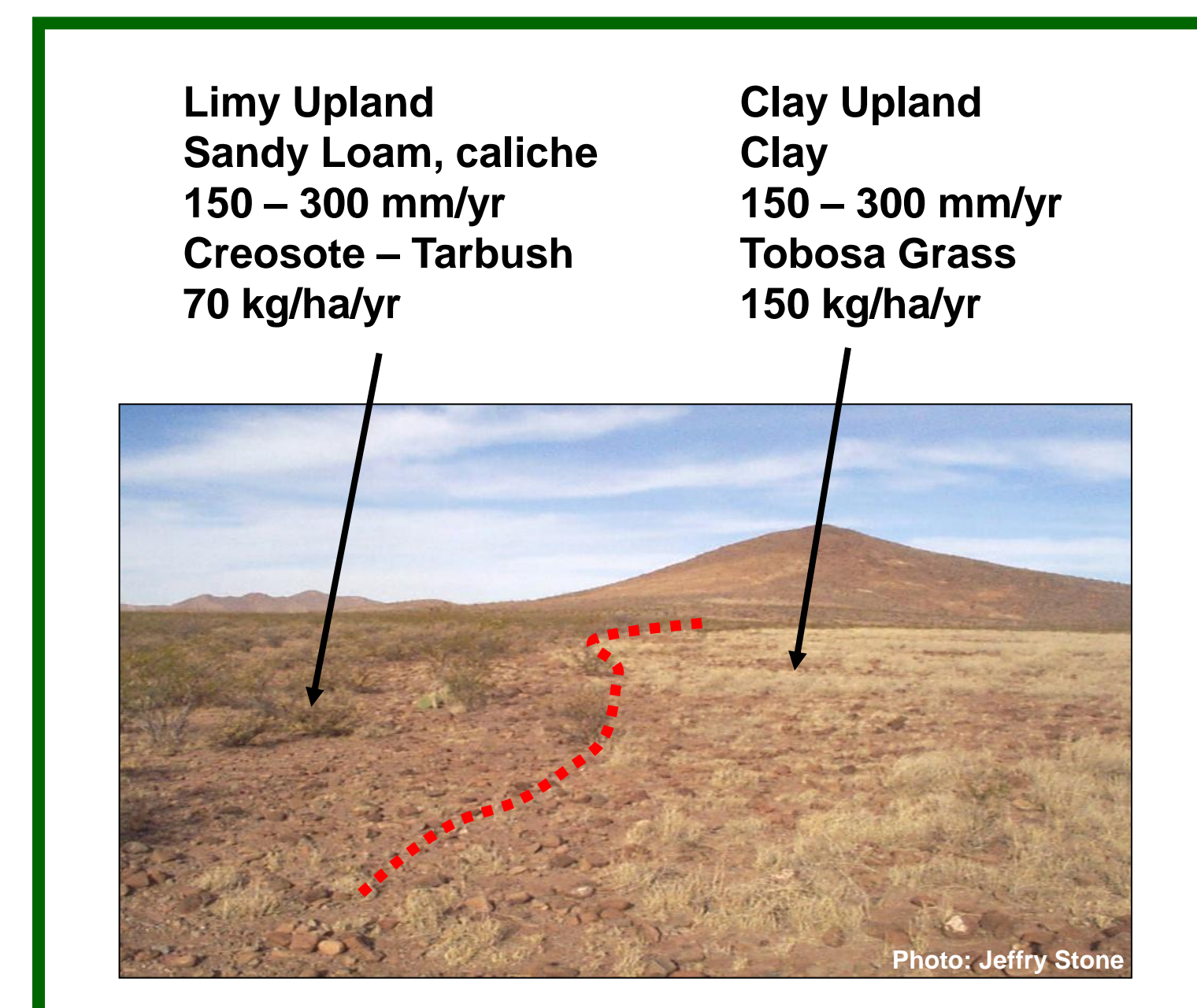
Walnut Gulch Experimental Watershed (WGEW)
Area: 150 sq.km.
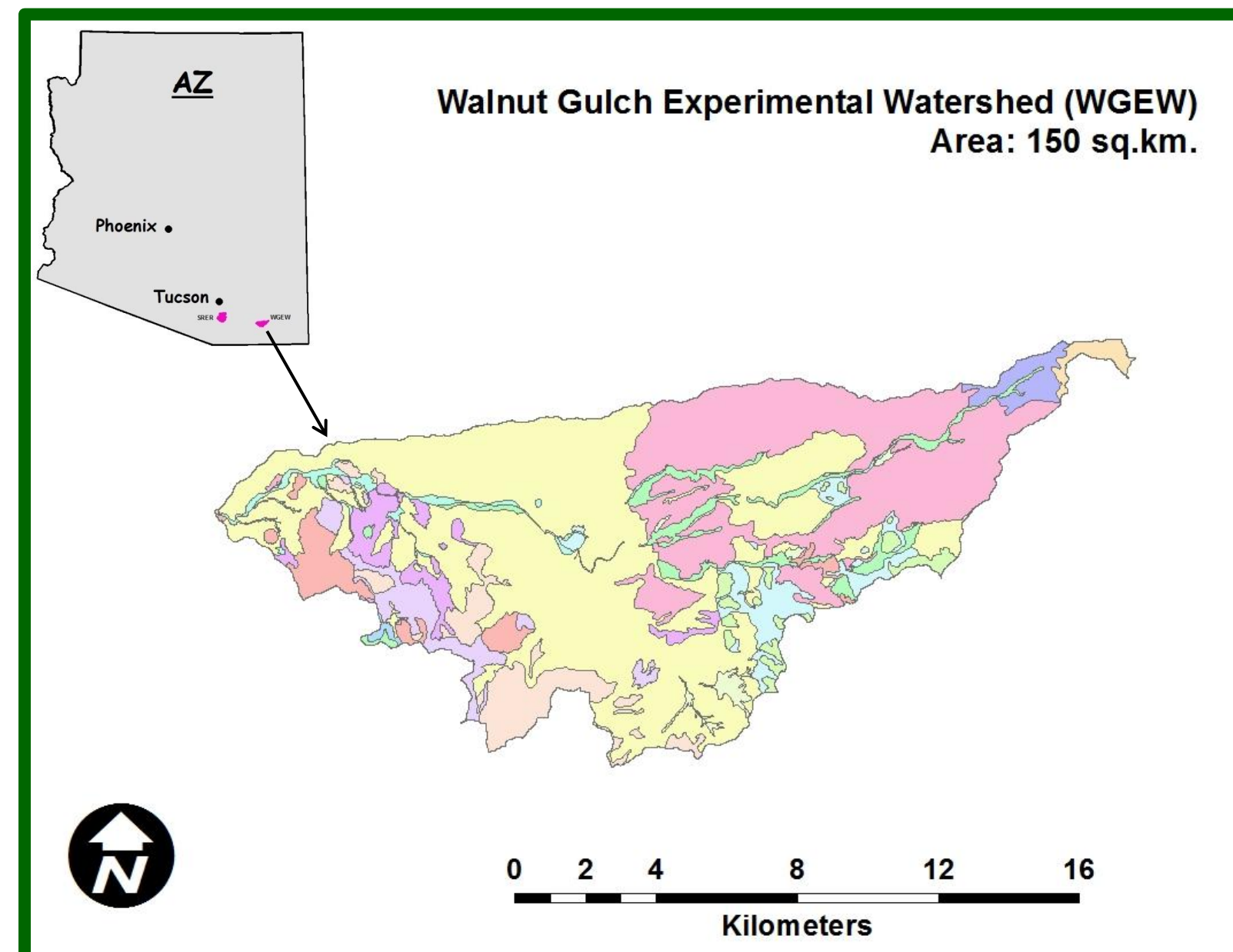
Santa Rita Experimental Range (SRER) is the first experimental range in the US. It is an outdoor laboratory founded in 1903.

Santa Rita Experimental Range (SRER)
Area: 206 sq.km.
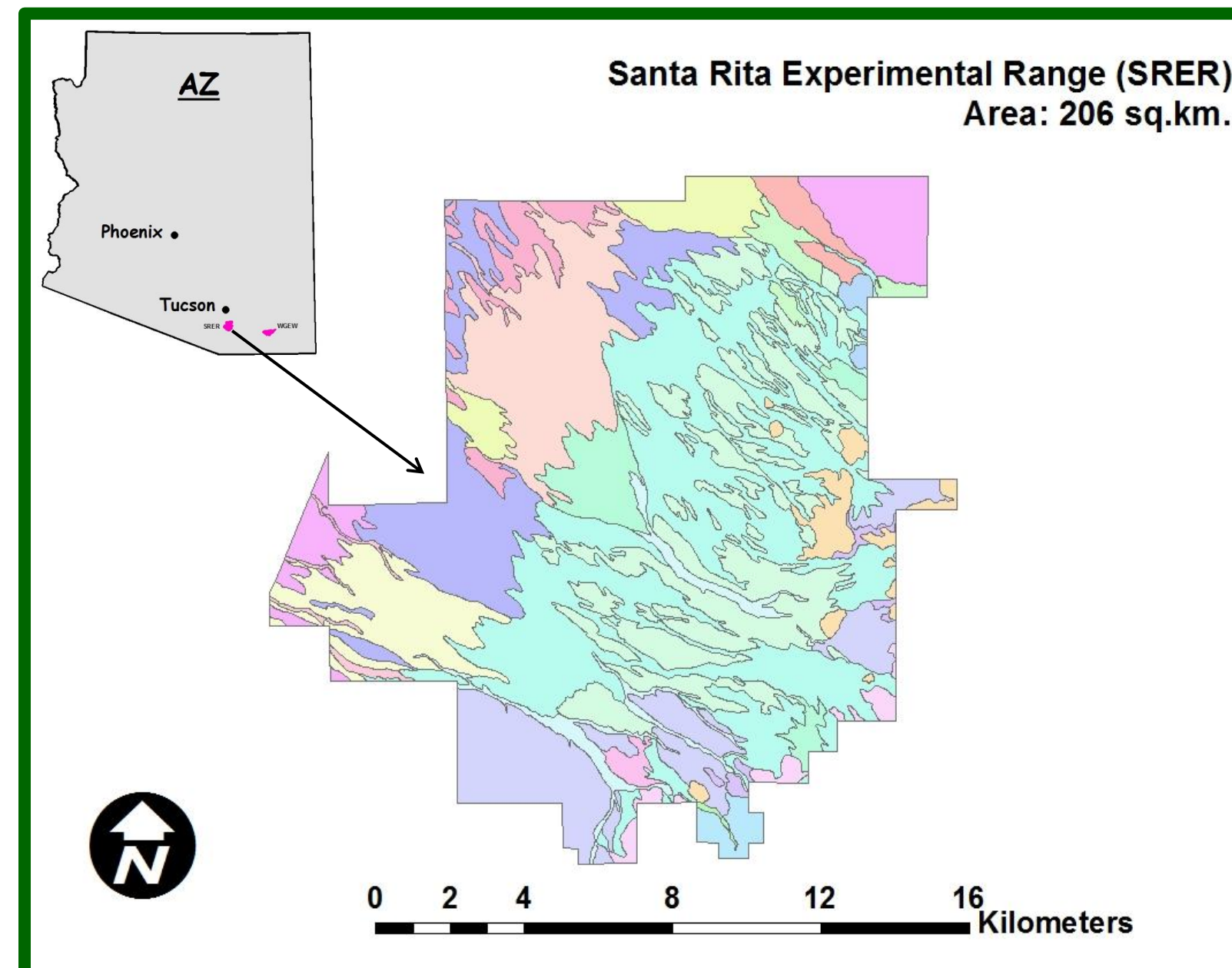
SSURGO reports for WGEW and SRER are available at the NRCS website and field based ecological site maps were prepared for both areas by the NRCS.

Ecological Site - Unit of Analysis

Ecological sites are areas with potential to produce vegetation communities of distinct kinds, amounts, and proportions. They are based on soil and climate.

Limy Upland
Sandy Loam, caliche
150 – 300 mm/yr
Creosote – Tarbush
70 kg/ha/yr

Clay Upland
Clay
150 – 300 mm/yr
Tobosa Grass
150 kg/ha/yr

Photo: Jeffry Stone

The USDA-NRCS developed state-and-transition-models (STMs) for each ecological site. In STMs, each ecological site can have multiple states.

State and Transition Model

MLRA 41-3 (12-16"), Loamy Upland 12-16 '' pz.
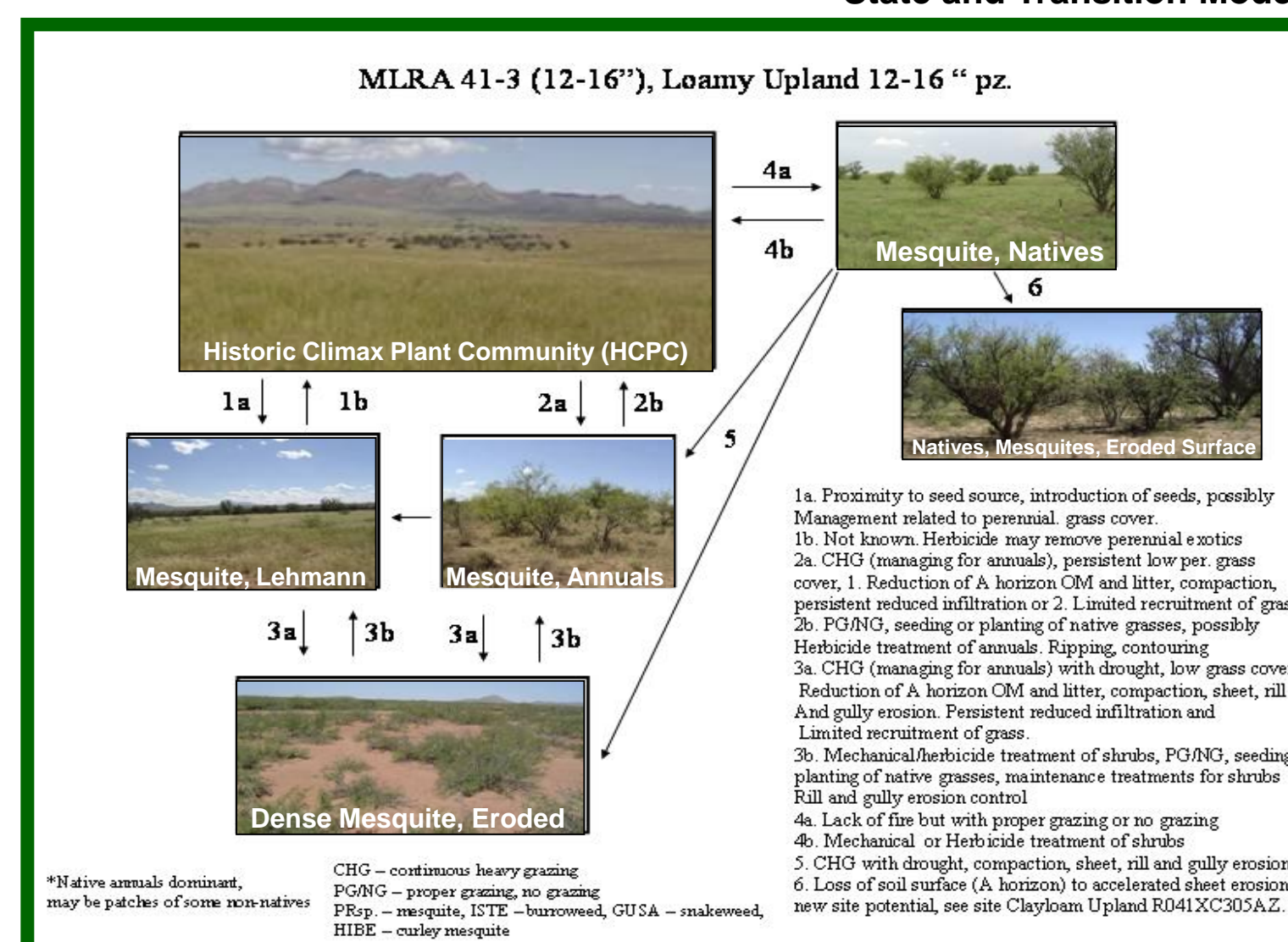
STMs are effective tools to describe management induced transitions of vegetation communities in rangelands.
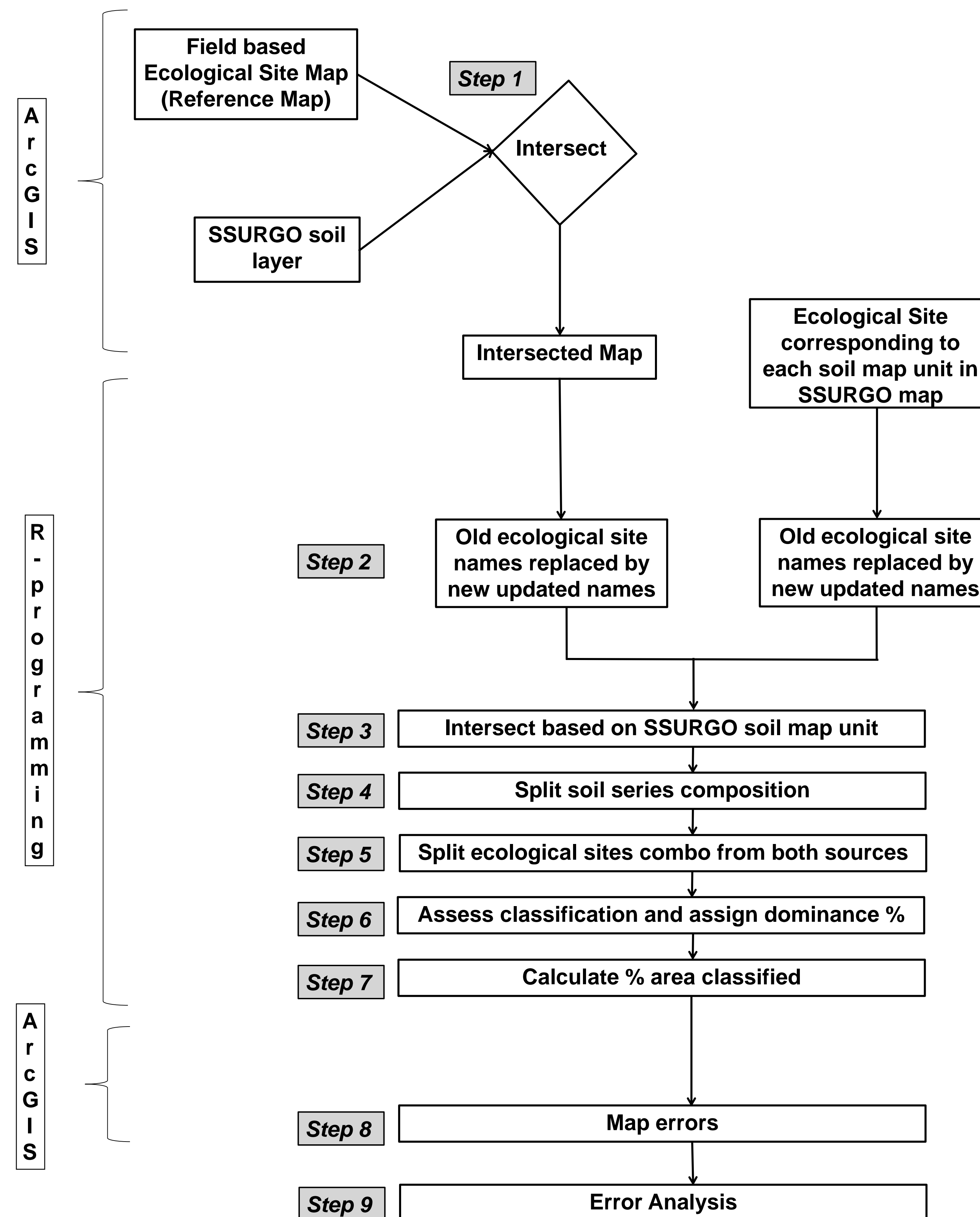
Methods

Field Based Map

1) Soil Survey is used to get the soil series.
2) Range specialists describe and compare plant communities on different soil map units.
3) Ecological site concepts are developed.
4) Soil groups having similar ecological processes are grouped together.
5) Ecological Site Descriptions are developed.

Soil Survey | Vegetation Survey

Photos: Dan Robinett
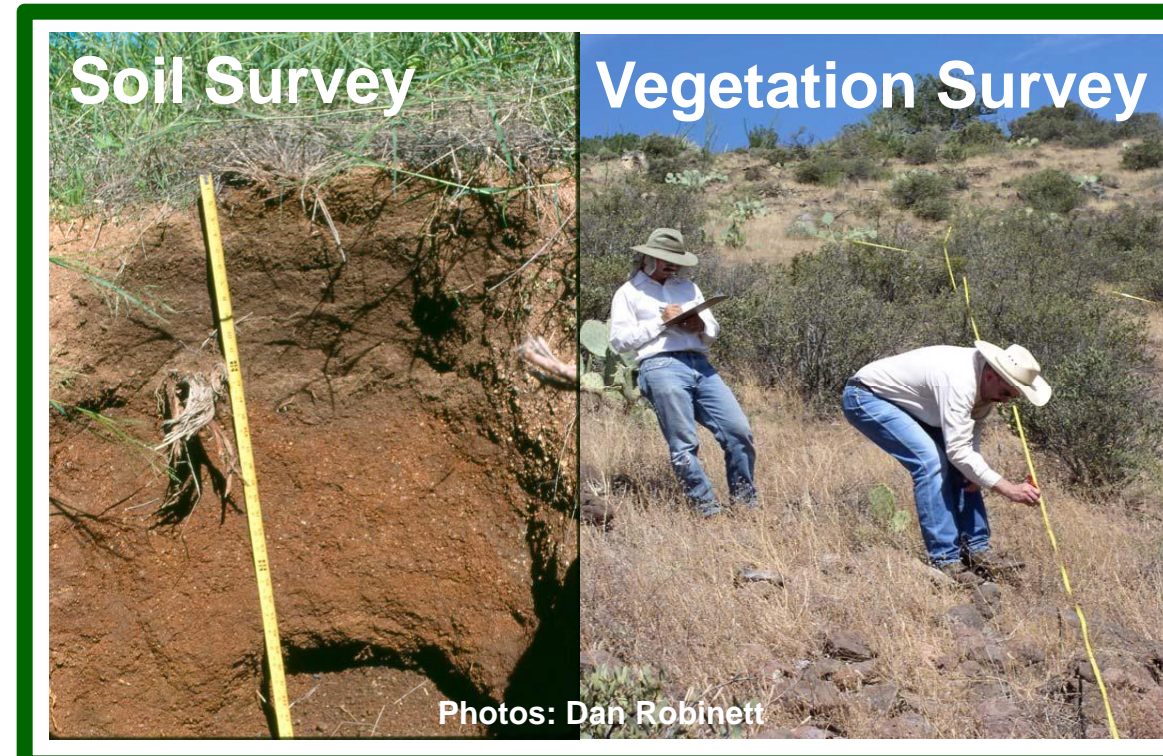
SSURGO Generated Map

1) SSURGO maps are a product of USDA-NRCS
2) After soil scientists identified the soil series, they drew boundaries on aerial photographs and identified each as a specific map unit.
3) The soil survey provides detailed information of soil including soil types, their suitability, limitations, and management for specified uses.
4) Range conservationists identified present and potential plant communities and assigned an ecological site to each soil series within soil map units.
5) Each soil map unit or the combination of the map units are associated with particular interpretive ecological site groups.

Error Assessment

ArcGIS

Field based Ecological Site Map (Reference Map) → Step 1

SSURGO soil layer

Intersect

Intersected Map

Ecological Site corresponding to each soil map unit in SSURGO map

R-programming

Step 2 — Old ecological site names replaced by new updated names | Old ecological site names replaced by new updated names

Step 3 — Intersect based on SSURGO soil map unit

Step 4 — Split soil series composition

Step 5 — Split ecological sites combo from both sources

Step 6 — Assess classification and assign dominance %

Step 7 — Calculate % area classified

ArcGIS

Step 8 — Map errors

Step 9 — Error Analysis

Results and Discussion

		WGEW	SRER
Area Classified / Total Area including Inclusions (%)		52	26
Area Classified / Total Area excluding Inclusions (%)		58	30
Inclusions* (%)		12	12

* Inclusions are soils that belong to taxonomic classes other than the major soils. They might include any of the soil types in that particular soil map unit or any other contrasting soil types.

	ERROR TYPE	REMARK
I	Loamy Upland as Sandy Loam Upland	Similar Productivity
II	Upland/Slopes/Hills/Fan/Deep – same soil type	Better DEM can help
III	Bottom/Swales – same soil type	-
IV	Upland Areas as Bottom/Swales – same soil type	Better DEM can help
V	Upland/Slopes/Hills/Fan/Deep – different soil type	Better DEM can help
VI	Bottom/Swales – different soil type	-
VII	Upland Areas as Bottom/Swales – different soil type	Better DEM can help
VIII	Precipitation Zone – Different MLRA	Outdated Soil Survey
IX	Soil Pits – Dumps classified as ecological sites	-

- Error type V was the most common error in the WGEW. Upland areas mapped as one soil type in the field based map were mapped as upland areas in different soil types, possible due to lumping for range management purpose.

- Second dominant error was error type VII, where upland areas in one soil type were mapped as bottom areas or vice versa in another soil type, possibly due to lumping.

- A good DEM can be used to identify the upland areas.

Error Assessment Results for WGEW

MLRA 41-1
MLRA 41-3
MLRA_AZ Error Polygons
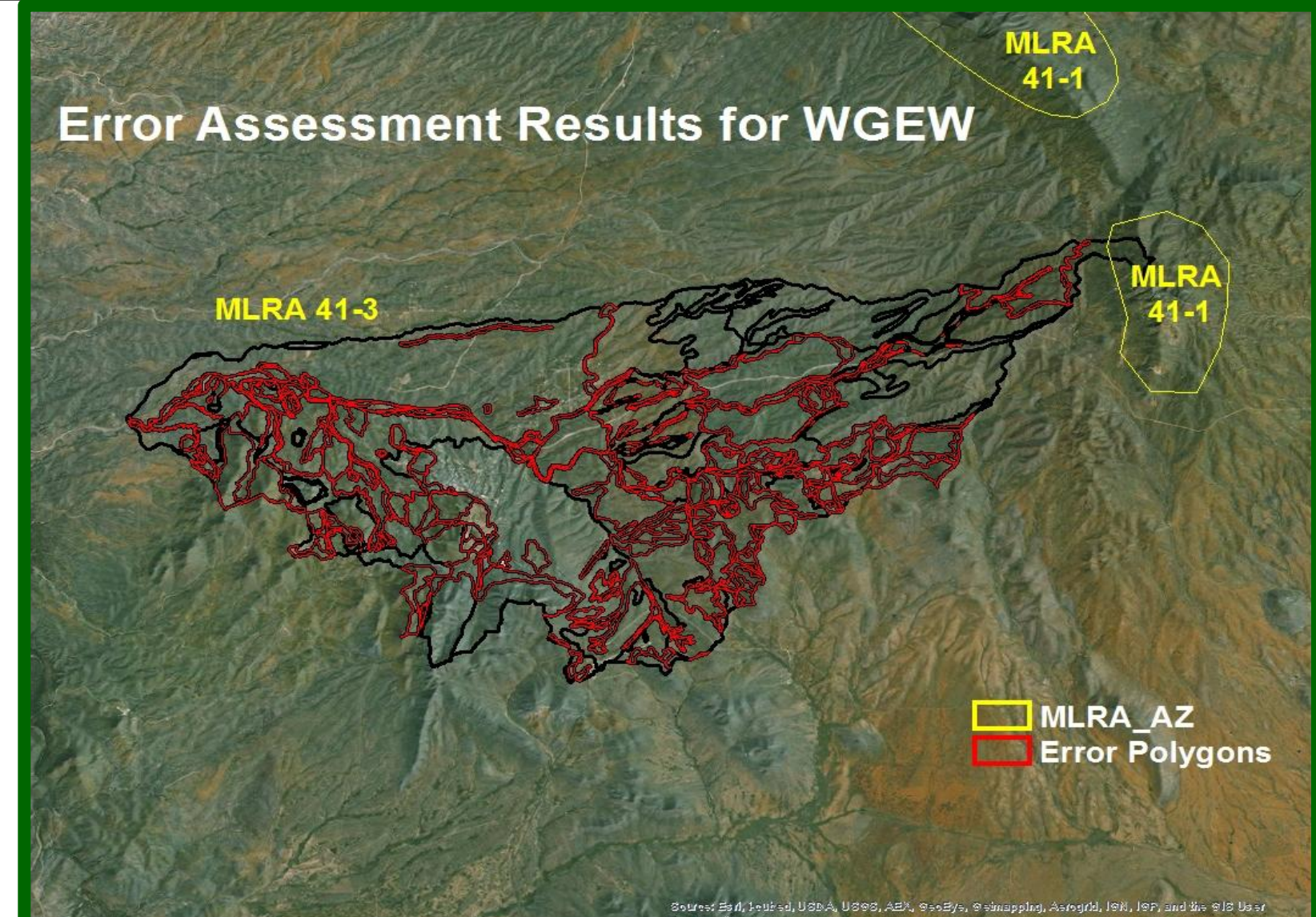
- In SRER, the most common error was Type VIII. A big part of the SRER in the northwest side falls under MLRA 40-1 with a precipitation zone of 10-13", but the SSURGO database maps this area as MLRA 41-3, which is a 12-16" precipitation zone.

- Second dominant error type was type V where upland areas mapped as one soil type in the field based reference map were mapped as upland areas in different soil types, possibly due to lumping.

- A good DEM and MLRA information can reduce the errors in the SRER ecological site map.

- The SSURGO report for Santa Cruz and parts of Cochise & Pima counties was an old report from the late 1970s. These older reports need updating.

Error Assessment Results for SRER

MLRA 40-1
MLRA 41-3
MLRA 41-1
MLRA_AZ Error Polygons
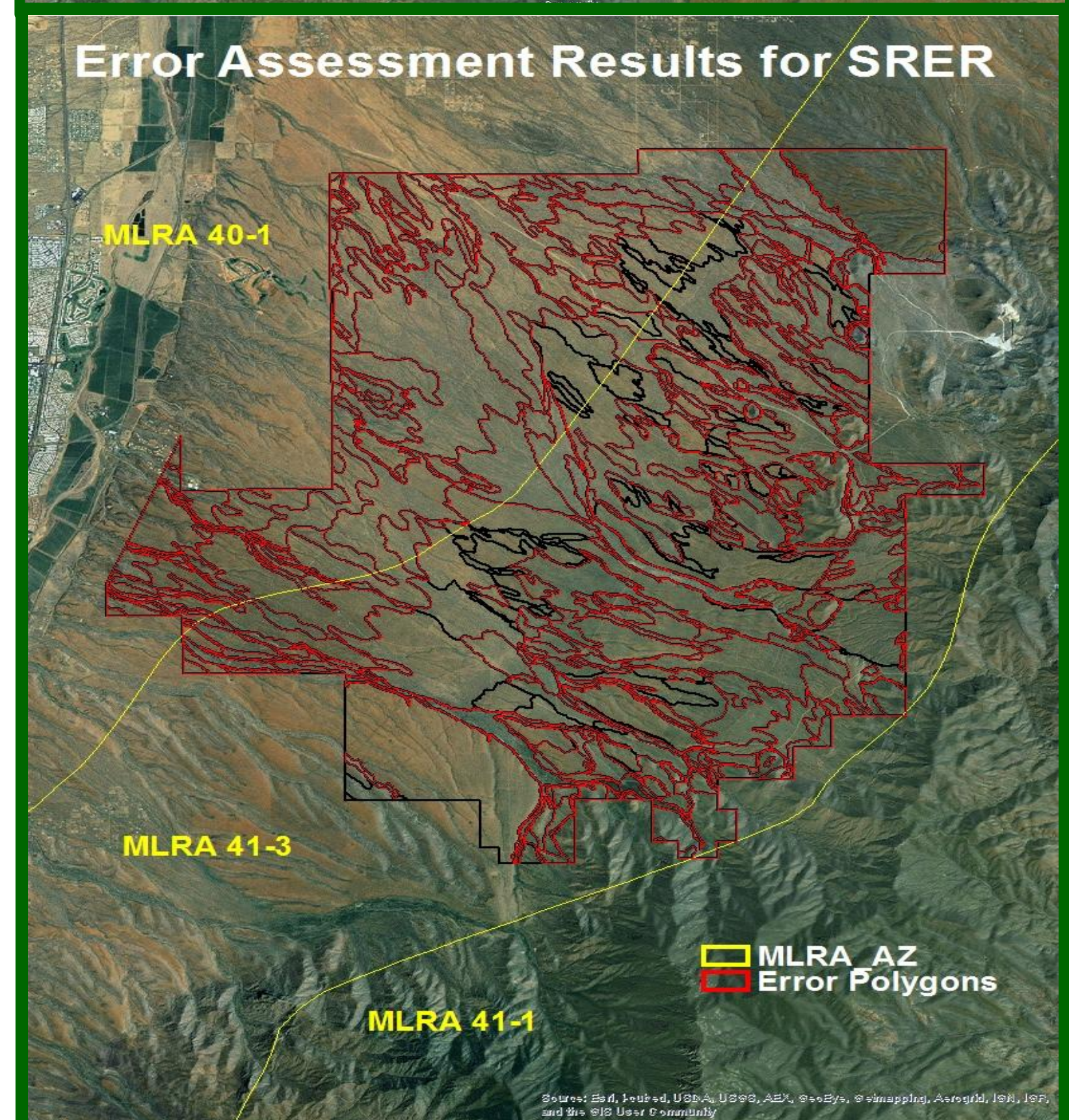
Conclusion

- Preliminary ecological site maps generated from the SSURGO database can definitely be a good option to get a first-cut distribution of ecological sites in an area. Field visits are always recommended for more precise results.

- ArcGIS is handy and R-programming is free to use.

- This study considers ecological sites associated with each soil series in the soil map unit, instead of just focusing on the ecological site type from the dominant soil series. Hence, the assessment considers the landscape heterogeneity.